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NESTING HABITAT OF LESSER PRAIRIE CHICKENS IN EASTERN NEW MEXICO

by

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Wisdom, M.J. 1977. Use of W.S.O. bird computer data bank in Wisconsin. Passenger Pigeon. 38(4): 158-162.

Wisdom, M.J. and C.A. Davis. 1979. Nesting habitat of lesser prairie chickens in eastern New Mexico. Proc., Prairie Grouse Technical Council. 13: In Press.

Davis, C.A., T.Z. Riley, J.F. Schwarz, H.R. Suminski, and M.J. Wisdom. 1980. Capturing female prairie chickens on spring leks. Proc., Prairie Grouse Symposium I: In Press.

Davis, C.A., T.Z. Riley, R.A. Smith, and M.J. Wisdom. 1980. Spring-summer foods of lesser prairie chickens in New Mexico. Proc., Prairie Grouse Symposium I: In Press.

ABSTRACT

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IN EASTERN NEW MEXICO

by

MICHAEL J. WISDOM

MASTER OF SCIENCE IN WILDLIFE SCIENCE

NEW MEXICO STATE UNIVERSITY

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Lesser prairie chicken (Tympanuchus pallidicinctus) nesting habitat was studied during 1976-78 on public lands in eastern Chaves County, New Mexico. Study area vegetation included the Shinnery Oak (Quercus havardii)-Tallgrass type on the duny, sandy soils occupying most of the area, and the Mesquite (Prosopis glandulosa)-Shortgrass type on the remaining flat expanses of tighter, clay soils. Shinnery Oak-Tallgrass included 3 subtypes. Subtypes 1 and 2 were dominated by grasses, especially sand bluestem (Andropogon hallii) in subtype 1 and little bluestem (Schizachyrium scoparium) in subtype 2. Subtype 3 was dominated by shinnery oak, and bluestems were scarce. The 3 subtypes represented progressive stages in deterioration of tallgrass prairie under livestock grazing, with subtype 1 nearest climax and subtype 3 most deteriorated.

Females nested only in the Shinnery Oak-Tallgrass vegetation type, under or beside plants that were taller than vegetation surrounding (9m) nest sites; the Mesquite-Shortgrass vegetation type, which contained almost no tall vegetation, was not used as nesting habitat.

Bluestem tallgrasses were preferred cover at (above and/or beside) nest sites; this preference resulted in highest nest densities in subtype 1, where bluestems were highest in composition and height and were grazed least; conversely, nest densities were lowest in subtype 3, where bluestems were sparse and heavily grazed.

Successful nests generally were those which: (1) were placed directly in cover of sand bluestem and which, in comparison with unsuccessful nests, had (2) higher composition of sand bluestem within 3m, (3) taller cover overhead and within 9m, and (4) taller, ungrazed or lightly grazed sand bluestem, little bluestem, and/or dropseed (*Sporobolus* spp.) within 9m.

This dependence on tallgrass cover, largely provided by sand bluestem, resulted in wide variations in nesting success between subtypes that corresponded directly with similar variations in composition, height, and grazing utilization of sand bluestem between the subtypes; nesting success was highest in subtype 1, where sand bluestem was highest in composition and height and was grazed least; success was lowest in subtype 3, where composition and height of sand bluestem were lowest, and grazing was heaviest.

These data indicate that vegetational composition of subtype 1 provides an appropriate goal for efforts to restore prime nesting habitat in shinnery-dominated areas of lesser prairie chicken range in eastern New Mexico, west and north Texas, and west-central Oklahoma; the abundant sand bluestem would not only provide superior residual cover for nesting females, but also would provide suitable livestock forage that is currently lacking.

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INTRODUCTION

Little is known about nesting habitat of lesser prairie chickens (Tympanuchus pallidicinctus); only 22 nest sites have been reported in the literature, and their descriptions were generally cursory. Bent (1932: 281) quoted Walter Colvin's general description of 3 nest sites in Kansas; Duck and Fletcher (ca. 1944: 70; photo only), Copelin (1963), Jones (1963), Sutton (1964), and Donaldson (1969) described a total of 11 nest sites in Oklahoma with varying precision. Sell (1979) reported overhead cover at 8 nest sites in Texas. Descriptions of nesting habitat in New Mexico have been limited to general statements, providing no specific data on individual nests (Bailey 1928, Ligon 1961).

Because of this dearth of information, this study was undertaken to elucidate quality nesting habitat and to develop pertinent management goals. Field work was conducted during the breeding seasons (March-June) of 1976 through 1978, on public lands in the Mescalero Sands area of eastern Chaves County, New Mexico, approximately 65 km east of Roswell.

The study was funded by the U.S. Department of Interior, Bureau of Land Management (BLM), and the New Mexico State University Agricultural Experiment Station. Equipment was provided by the New Mexico Department of Game and Fish and the U.S. Department of Interior, Fish and Wildlife Service. Dr. Charles A. Davis, Professor, Department of Fishery and Wildlife Science, guided the study as the principal investigator and devoted many extra hours to the planning, analysis, and writing phases.

J. F. Schwarz, BLM Contracting Officer's Authorized Representative, was of great assistance in planning and guiding the study and in conducting field work. T. Z. Riley, R. A. Smith, and H. R. Suminski, wildlife graduate students at New Mexico State University, provided invaluable field assistance. Numerous other wildlife students assisted in field work, as did BLM employees. Dr. Melchor Ortiz, Assistant Professor, Department of Experimental Statistics, provided many hours of statistical and computer programming assistance.

STUDY AREA

The study was conducted on approximately 15,500 ha of public lands in the East Chaves Planning Unit of the Roswell, New Mexico District of the BLM. The area is about 65 km east of Roswell, and lies north of U.S. Highway 380 and south of U.S. 70. Topography varies from flat to undulating and dunelike.

Vegetation includes 2 principal types (Figure 1). The Shinnery Oak(*Quercus havardii*)[1]-Tallgrass type occurs on the sandy, duny soils which occupy 90% (13,650 ha) of the area, and the Mesquite (*Prosopis glandulosa*)-Shortgrass type (1,850 ha) occurs on the remaining flat expanses of tighter soils. Shinnery Oak-Tallgrass includes 3 subtypes. Subtype 1 is located in 1 large pasture where livestock grazing is relatively light, and in a few small areas remote from livestock water; this subtype has the most plant growth and litter (Table 1), the most sand bluestem (*Andropogon hallii*) (Table 2), the tallest grass cover (Table 3), and is grazed the least (Table 4). Thus, vegetation of subtype 1 is near climax, with a small level of disturbance caused by relatively light grazing.

Subtypes 2 and 3 (Figure 1) apparently represent progressive stages in deterioration of tallgrass prairie under prolonged, heavy grazing. In comparison with subtype 1, they have less total plant growth (Table 1), less sand bluestem (Table 2), shorter grass cover (Table 3), and heavier livestock grazing (Table 4). Also, subtype 3

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[1] Common and scientific plant names follow Correll and Johnston (1970).

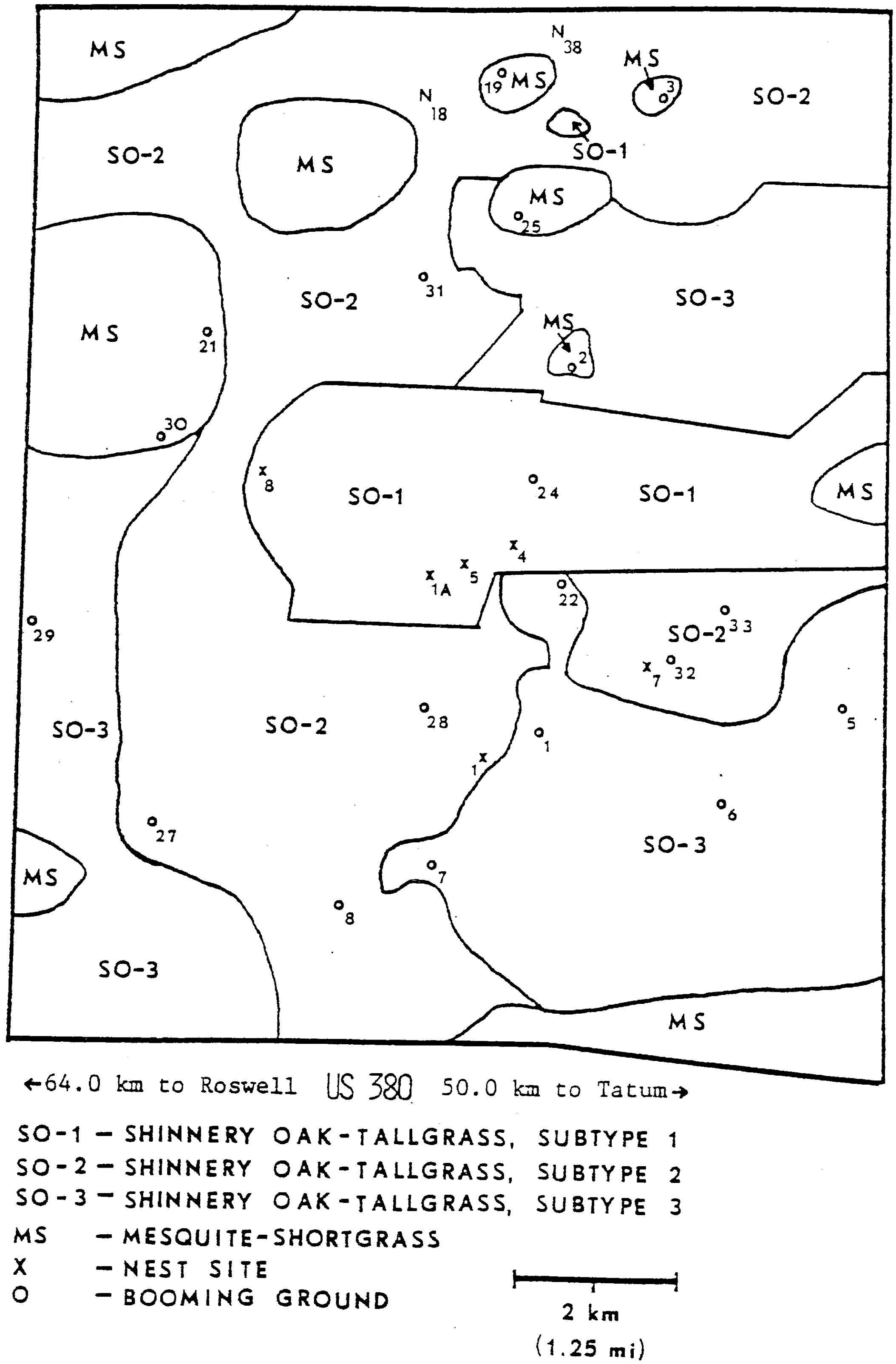

Figure 1. Vegetation types and subtypes on study area

Table 1. Mean (±95% CI) percent ground cover[a] in the Shinnery Oak-Tallgrass subtypes. Sample sizes in parentheses.

Shinnery Oak-Tallgrass	Plant	Litter	Bare
Subtype 1 (30)	18.8 ± 2.1	42.9 ± 2.4	38.3 ± 1.8
Subtype 2 (60)	11.7 ± 1.2	32.8 ± 2.0	55.5 ± 1.1
Subtype 3 (32)	9.2 ± 0.5	31.7 ± 1.7	59.1 ± 1.9

[a] Ground cover estimated using step-point transects (Evans and Love 1957).

Table 2. Mean (±95% CI) percent basal composition[a] of vegetation in the Shinnery Oak-Tallgrass subtypes. Sample sizes in parentheses.

Species	Subtype 1 (30)	Subtype 2 (60)	Subtype 3 (32)
Grasses			
Sand bluestem	26.8 ± 2.3	8.5 ± 1.5	5.0 ± 1.5
Three-awn	7.7 ± 1.1	16.7 ± 1.5	13.3 ± 1.8
Hairy grama	7.3 ± 1.1	6.7 ± 1.0	3.8 ± 1.3
Little bluestem	5.2 ± 0.9	12.1 ± 1.6	5.8 ± 1.2
Fall witchgrass	4.5 ± 1.2	4.6 ± 0.9	4.6 ± 1.1
Dropseed	3.4 ± 1.1	3.7 ± 0.7	5.5 ± 0.6
Sand lovegrass	1.4	3.2	0.9
Paspalum	0.6	1.6	1.9
False buffalograss	0.6	0.7	1.1
Others	0.3	0.3	0.3
Total Grasses	57.8 ± 2.4	58.1 ± 2.5	42.2 ± 2.1
Shrubs			
Shinnery oak	29.1 ± 3.1	29.1 ± 1.9	43.8 ± 2.7
Yucca	0.7	1.3	0.7
Sand sagebrush	0.5	0.3	0.9
Others	0.5	0.2	0.4
Total Shrubs	30.8 ± 2.9	30.9 ± 2.1	45.8 ± 2.8
Forbs	11.4 ± 2.7	11.0 ± 2.1	12.0 ± 2.1

[a]Basal composition of vegetation estimated using step-point transects (Evans and Love 1957).

Table 3. Mean height (cm) of the major livestock forage grasses within 9m of nest sites in the Shinnery Oak-Tallgrass subtypes. Sample sizes in parentheses.

Species	Subtype 1	Subtype 2	Subtype 3	Probability[a]
Sand bluestem	75.0 (190)	25.2 (452)	11.9 (67)	< 0.001
Little bluestem	58.5 (165)	35.3 (436)	12.9 (118)	< 0.001
Dropseed	37.3 (171)	22.7 (457)	15.5 (149)	< 0.001

[a]Probability of a larger difference than that observed between subtypes for each species; level of significance determined by analysis of variance test.

Table 4. Percent grazing utilization[a] of the major livestock forage grasses within 9m of nest sites in the Shinnery Oak-Tallgrass subtypes. Sample sizes in parentheses.

Species	Subtype 1	Subtype 2	Subtype 3	Probability[b]
Sand bluestem	31.5 (190)	67.2 (448)	81.8 (68)	< 0.001
Little bluestem	12.5 (167)	21.5 (435)	51.6 (118)	< 0.001
Dropseed	35.2 (173)	57.3 (458)	68.1 (149)	< 0.001

[a] Grazing utilization estimated from height-weight tables developed after Crafts (1938).

[b] Probability of a larger difference than that observed between subtypes for each species; level of significance determined by analysis of variance test.

has less total grass and more shrub cover (especially shinnery oak) than either subtypes 1 or 2.

The Mesquite-Shortgrass type (Table 5) is dominated by blue grama (Bouteloua gracilis) and buffalograss (Buchloe dactyloides). Mesquite is the most conspicuous plant in many areas of this type, although it is insignificant in the composition.

Principal use of the study area is for grazing by cattle; the area also is subjected to extensive and continuous exploration and development for production of oil and gas.

Climate of the area (Maker et. al 1971) is semi-arid and continental, with distinct seasons, wide ranges of diurnal and seasonal temperatures, and plentiful sunshine. Nearly 75% of the annual precipitation (30-year average, 34.5 cm) falls during the growing season, May through October, mostly from brief but often intense thunderstorms. Daytime temperatures reach 32°C or higher on most days from mid-May through Mid-September, and commonly reach 38°C or higher from June through August. Nighttime temperatures generally are about 15°C cooler.

Table 5. Mean (± 95% CI) percent basal composition of vegetation in the Mesquite-Shortgrass vegetation type. Sample size in parentheses.

Species	Percent Composition (30)
Grasses	
Blue grama	63.5 ± 6.1
Buffalograss	15.9 ± 7.5
Three-awn	6.0 ± 3.0
Dropseed	2.8
Sideoats grama	0.6
Others	0.3
Total Grasses	89.1 ± 12.5
Shrubs	
Broom snakeweed	5.5 ± 2.8
Others	0.6
Total Shrubs	6.1 ± 3.0
Forbs	
Croton	1.4
Unclassified forbs	3.4
Others	Trace
Total Forbs	4.8 ± 3.4

[a]Basal composition of vegetation estimated using step-point transects (Evans and Love 1957).

METHODS

Forty-eight females were captured on spring leks (Davis et. al 1980) by using cannon nets (Dill and Thornsberry 1950) and vertical mist nets (Campbell 1972). Females were radio-tagged (Riley 1978) and their movements followed to find 33 nests; 4 other nests were found during routine field work. Nesting success, defined as the percent of nests hatching young, was determined for 36 of the 37 nests.

At each nest site, the species of plant (usually 1 individual) providing the principal cover directly above or beside the nest was recorded and its height measured. Vegetation within 3m of each nest was sampled using line-point transects (Heady et. al 1959) that were arranged as a cluster of 8 lines radiating outward from the nest, with 1 line placed in each of the 8 major compass directions (north, north-east, east, etc.). Each line had 10 data points spaced 0.3m apart, so that each cluster of 8 lines yielded 80 points. The species of plant rooted nearest and ahead of each point was recorded for use in calculating the percent composition (Levy and Madden 1933) of each species near the nest. Height of vegetation on or nearest every third data point also was measured.

Height of 24 randomly selected individuals of each of the 3 important forage grasses -- sand bluestem, little bluestem (*Schizachyrium scoparium*), and dropseed (*Sporobolus* spp.) -- was measured within 9m of each nest. When fewer than 24 plants of any of these grasses were present, the sample was considered complete when it included all individuals (of each species) present.

Topography surrounding 14 nest sites was measured using an Abney level in 1978. The percent slope from the nest to the highest point within 60m was measured in 8 compass directions (north, northeast, east, etc.).

For data subject to statistical analysis, a non-parametric test (randomization test, Sokal and Rohlf 1968: 629) was used to compare samples containing less than 30 observations, while larger samples ($n \geq 30$) were compared using parametric tests (analysis of variance test, chi square test, confidence intervals, and Student's t-test).

NEST SITES

Females in each subtype of Shinnery Oak-Tallgrass selected taller vegetation for cover at the nest (above and/or against the nest) than was generally available (Table 6). The Mesquite-Shortgrass vegetation type, which contained almost no tall vegetation, was not used as nesting habitat.

Females used a variety of plant species as cover at the nest. Results in Table 7 suggest a strong preference for bluestem tallgrass in subtype 1; 78% of the nest sites were clumps of bluestem, although these species collectively composed only 32% of the vegetation. Bluestems existed in a tall, lightly grazed condition in this subtype (Tables 3, 4), and this apparently attracted females seeking taller vegetation for nesting cover (Table 6). Other species in subtype 1 were not used heavily as nest cover; shinnery oak was used sparingly (1 nest, 11%) compared to its availability (29% of the composition), and the 1 nest found under yucca (*Yucca* sp.) was closely surrounded by sand bluestem which provided most of the nest concealment.

In subtype 2, bluestems made up a smaller part of the vegetation (21%), but more importantly were shorter (Table 3) and more heavily grazed (Table 4); hence, bluestems were less attractive as potential nest cover compared to subtype 1. Under these conditions, nesting females still used bluestems in greater proportion than they occurred in the vegetation (Table 7), but females also used three-awns (*Aristida* spp.) and broom groundsel (*Senecio spartoides*) and made increased use of shrubs, especially sand sagebrush (*Artemesia filifolia*).

Table 6. Mean height (cm) of vegetation directly above nests versus mean height of vegetation within 9m of nests in the Shinnery Oak-Tallgrass subtypes. Samples sizes in parentheses.

Subtype	Above Nests	Within 9m of nests	Probability[a]
1	63.8 (9)	31.0 (9)	0.007
2	42.7 (21)	23.9 (21)	0.001
3	33.8 (7)	20.8 (7)	0.029
All Subtypes	43.4 (37)	17.8 (37)	0.001

[a]Probability of a larger difference than that observed within each subtype; level of significance determined by randomization test (Sokal and Rohlf 1968: 629).

Table 7. Percent use of each plant species as nest cover[a] versus its availability,[b] by Shinnery Oak-Tallgrass subtype. Sample sizes in parentheses.

Species	Subtype 1		Subtype 2		Subtype 3	
	Use (% of nests)	Availability (% composition)	Use (% of nests)	Availability (% composition)	Use (% of nests)	Availability (% composition)
Sand bluestem	44.4 (4)	26.8	9.5 (2)	8.5	0	5.0
Little bluestem	33.3 (3)	5.2	33.3 (7)	12.1	0	5.8
Silver bluestem	0	Trace	4.8 (1)	Trace	0	Trace
Three-awn	0	7.7	23.8 (5)	16.7	28.5 (2)	13.3
Total Grasses	77.7 (7)	39.7	71.4 (15)	37.3	28.5 (2)	24.1
Sand sagebrush	0	0.5	14.3 (3)	0.3	28.5 (2)	0.5
Shinnery oak	11.1 (1)	29.1	9.5 (2)	29.1	14.3 (1)	43.8
Yucca	11.1 (1)	0.7	0	1.3	14.3 (1)	0.7
Total Shrubs	22.2 (2)	30.3	23.8 (5)	30.7	57.1 (4)	45.0
Broom groundsel	0	Trace	4.8 (1)	Trace	14.3 (1)	Trace
Total forbs	0	11.4	4.8 (1)	11.0	14.3 (1)	12.0

[a]Principal cover at the nest, i.e., directly above or against the nest.

[b]Percent composition in each subtype, from Table 2; this gives an approximate indication of availability although height and grazing utilization of these plants further indicate availability as it relates to nest cover.

In subtype 3, bluestems were nearly unavailable for use as cover at the nest (only 11% of the vegetation) and were shorter (Table 3) and more heavily grazed (Table 4) than in either subtypes 1 or 2. Thus, all nests were under or beside plants usually not preferred as livestock forage, such as three-awns, yucca, and sand sagebrush (Table 7). In this heavily grazed situation, sand sagebrush was used most often relative to its availability (Table 7), apparently as substitute nest cover in the absence of suitable bluestem cover. Sell (1979) found sand sagebrush to be preferred nest cover on similar overgrazed shinnery rangeland in western Texas that was equally devoid of bluestems.

The preference to use bluestems as nest cover in areas where these grasses existed in a tall, lightly grazed condition also was reflected in the relative density of nests in the 3 subtypes of Shinnery Oak-Tallgrass. In subtype 1, where bluestems were most abundant (Table 2), tallest (Table 3), and grazed least (Table 4), nest densities were highest as shown by preference indices (Table 8); nearly twice as many nests were found in subtype 1 than were expected if nests had been placed randomly across the subtypes (Table 8). Conversely, in subtype 3, where bluestems were least abundant (Table 2), shortest (Table 3), and grazed heaviest (Table 4), one-half as many nests were found as were expected, assuming random nest placement (Table 8). Chi square analysis also indicated that nests were not placed randomly across the subtypes (Table 8). This close agreement between nest density and bluestem abundance is evident especially when relative index values for these parameters are compared in each subtype (Table 9).

Table 8. Preference indices and chi square analysis of relative use of Shinnery Oak-Tallgrass subtypes for nesting.

	Shinnery Oak-Tallgrass Subtypes			
	1	2	3	Total
No. Nests				
Observed	9	21	7	37
Expected[a]	5 (13.5)[b]	18 (49.4)	14 (37.1)	37 (100.0)
Preference Index (Observed ÷ Expected)	1.80	1.17	0.50	-
Chi Square Data (Observed ÷ Expected)^2 ÷ Expected	3.20	0.50	3.50	7.20[c]

[a]Expected number assumes random placement of nests across subtypes by nesting females; number of nests expected in each subtype is then computed by multiplying the percent area of each subtype by the total number of nests (37).

[b]Percent area each subtype occupies within the total area of Shinnery Oak-Tallgrass.

[c]$P < 0.05$ for chi square value of 7.20 with 2 degrees of freedom.

Table 9. Indices to bluestem composition and nest density in the Shinnery Oak-Tallgrass subtypes.

Subtype	Index to Bluestem Composition[a]	Index to Nest Density[b]
1	3.0	3.6
2	1.9	2.3
3	1.0	1.0

[a]Bluestem composition in each subtype (Table 2) divided by bluestem composition in subtype 3 (Table 2), where value was lowest.

[b]Preference index for nesting in each subtype (Table 8) divided by preference index for nesting in subtype 3 (Table 8), where value was lowest.

Topography also influenced selection of nest sites. Thirty-four of 37 nests were associated with sandhills. All 34 nests were placed either on north-facing or northeast-facing slopes or in small depressions within sandhills. Almost invariably, high dunes were located to the south and west of nest sites; average maximum slopes were highest to the southwest of the 14 nests for which percent slope was measured (Table 10). Protection from prevailing southwest winds and/or from other extremes in microhabitat (direct sun, higher temperatures, etc.) apparently were important factors influencing nest site selection. Sell (1979) also found that most nests in western Texas were associated with sandhills.

Table 10. Average maximum slopes within 60m of 14[a] nests, 1978.

Direction	Average Maximum Slope[b] %
N	1.9
E	2.0
SE	1.9
S	3.8
SW	5.4
W	3.4

[a]Sample includes 12 nests associated with sandhills and 2 nests found on sandy plains.

[b]Slopes measured using an Abney level from nest site radiating outward in each compass direction; the maximum slope reading was recorded from the highest point measured within 60m in each direction of the nest.

NESTING SUCCESS

Nesting success (percent of nests hatching young) was related to tallgrass cover at the nest (above and/or against the nest). Success was greatest where sand bluestem was the principal cover at the nest (Table 11); silver bluestem (*Bothrichloa saccharoides*) is discounted because of inadequate sample size. In the study area, sand bluestem commonly forms a tall, wide clump with individual stems not closely spaced, allowing females to nest within the clump and be sufficiently concealed from both overhead and ground level disturbances. Only 2 (7.7%) of the 26 unsuccessful nests were placed in cover of sand bluestem, and these 2 were in low clumps were potential concealment had been reduced considerably by livestock grazing.

The growth form (height, width, shape, etc.) of other plant species used as nest cover usually did not provide the superior concealment afforded by sand bluestem. Little bluestem commonly grew in small, tight clumps which usually were both too dense and too small (narrow) to enclose and therefore completely conceal nests. Likewise, three-awn clumps usually were not wide nor tall enough to sufficiently conceal nests from ground level or from overhead. The shrub (sand sagebrush, shinnery oak, yucca) and forb (broom groundsel) species used as nest cover provided overhead cover with their wide, leafy foliage, but their sparse, thin stems underneath made these nests rather conspicuous when viewed from ground level. These cryptic deficiencies in the growth forms of plants described above were no

Table 11. Nesting success in relation to principal cover at (above and/or against) the nest.

Nest Placement	Nests Started	Nests Successful	
Species	No.	No.	Percent
Grasses			
Sand bluestem	6	4	67
Little bluestem	9	2	22
Silver bluestem	1	1	100
Three-awn	7	1	14
Total	23	8	34
Shrubs			
Sand sagebrush	5	1	20
Shinnery oak	4	0	0
Yucca	2	1	50
Total	11	2	18
Forbs			
Broom groundsel	2	0	0
Total	2	0	0

doubt responsible for lower success of nests associated with these species in contrast to nests concealed by sand bluestem (Table 11).

Nesting success also was related to tallgrass cover around the nest (within 3m). Sand bluestem (and also total grass) was more abundant within 3m of successful nests than within a similar radius of unsuccessful nests in both subtypes 1 and 2 (Tables 12, 13), reflecting its superior screening qualities. In subtype 3, where sand bluestem was nearly unavailable (Table 2) due to heavy livestock grazing (Table 4), the 1 successful nest was associated with a heavy growth of dropseed (Table 14).

Height of vegetation also affected nesting success. Plants at successful nests usually provided superior concealment above the nests; these plants were taller than those at unsuccessful nests (Table 15). Around the nest, overall vegetation was likewise taller for successful than for unsuccessful nests (Table 16). This difference was due largely to grazing; sand bluestem, little bluestem, and dropseed, the major forage grasses in the study area, were taller (Table 17) around successful nests than around unsuccessful nests (with the exception of sand bluestem and dropseed in subtype 2), as a result of being more lightly grazed near sites of successful nests (Table 18).

The influence of sand bluestem cover on nesting success is illustrated further by the large variation in nesting success between the subtypes of Shinnery Oak-Tallgrass (Table 18). Success was highest (66%) in subtype 1, where sand bluestem was highest in composition (Table 2) and height (Table 3) and was grazed least (Table 5). In subtype 2, where composition and height of sand bluestem were

Table 12. Mean percent basal composition of vegetation within 3m of successful nests versus that within 3m of unsuccessful nests in Shinnery Oak-Tallgrass subtype 1. Sample sizes in parentheses.

Species	Successful Nests (5)	Unsuccessful Nests (3)	Probability[a]
Grasses			
Sand bluestem	39.5	23.8	0.023
Little bluestem	6.3	5.8	0.844
Dropseed	3.0	6.7	0.372
Three-awn	7.8	2.9	0.118
Hairy grama	4.5	6.7	0.650
Fall witchgrass	2.5	2.5	-
Paspalum	0.2	0.8	-
Sand lovegrass	0.2	0	-
Others	0	0.4	-
Total	64.0	49.6	0.011
Shrubs			
Shinnery Oak	30.3	29.6	0.823
Yucca	0.5	1.3	-
Sand sagebrush	1.5	0	-
Others	0.2	0.4	-
Total	32.5	31.3	0.862
Forbs - Total	3.5	19.1	0.072

[a]Probability of a larger difference than that observed between means of each species; level of significance determined by randomization test (Sokal and Rohlf 1968: 629).

Table 13. Mean percent basal composition within 3m of successful nests versus that within 3m of unsuccessful nests in Shinnery Oak-Tallgrass subtype 2. Sample sizes in parentheses.

Species	Successful Nests (4)	Unsuccessful Nests (17)	Probability[a]
Grasses			
Sand bluestem	14.1	7.6	0.046
Little bluestem	5.6	5.3	0.892
Dropseed	7.2	5.8	0.654
Three-awn	16.6	12.6	0.197
Hairy grama	4.4	4.2	0.999
Fall witchgrass	3.8	5.1	-
Paspalum	1.9	2.9	-
Sand lovegrass	0.6	1.0	-
Others	0.9	0	-
Total Grasses	55.1	44.5	0.025
Shrubs			
Shinnery Oak	40.9	46.0	0.175
Yucca	0.9	1.0	-
Sand sagebrush	0	0.8	-
Others	0	0.3	-
Total Shrubs	41.8	48.1	0.197
Forbs - Total	3.1	7.4	0.597

[a] Probability of a larger difference than that observed between means of each species; level of significance determined by randomization test (Sokal and Rohlf 1968: 629).

Table 14. Mean percent basal composition of vegetation within 3m of 1 successful nest versus that within 3m of unsuccessful nests in Shinnery Oak-Tallgrass subtype 3. Sample sizes in parentheses.

Species	Successful Nests (1)[a]	Unsuccessful Nests (6)
Grasses		
Sand bluestem	0	2.3
Little bluestem	0	0.6
Dropseed	21.3	9.0
Three-awn	2.5	17.3
Hairy grama	0	2.5
Fall witchgrass	0	5.4
Paspalum	0	0.8
Total Grasses	23.8	37.9
Shrubs		
Shinnery oak	57.5	49.8
Yucca	6.2	1.0
Sand sagebrush	2.5	2.7
Others	0	1.2
Total Shrubs	66.2	54.7
Forbs - Total	10.0	7.4

[a]Statistical comparisons of means not feasible due to sample size of 1 for successful nests.

Table 15. Mean height (cm) of vegetation directly above successful nests versus that above unsuccessful nests in the Shinnery Oak-Tallgrass subtypes. Sample sizes in parentheses.

Subtype	Successful Nests	Unsuccessful Nests	Probability[a]
1	87.4 (5)	36.6 (3)	0.034
2	55.9 (4)	39.5 (17)	0.045
3	50.0 (1)	31.2 (6)	[b]
All Subtypes	66.6 (10)	34.9 (26)	0.017

[a]Probability of a larger difference than that observed within each subtype; level of significance determined by randomization test (Sokal and Rohlf 1968: 629).

[b]Statistical comparison of means not feasible due to sample size of 1 for successful nests.

Table 16. Mean height (cm) of vegetation within 9m of successful nests versus that within 9m of unsuccessful nests in the Shinnery Oak-Tallgrass subtypes. Sample sizes in parentheses.

Subtype	Successful Nests	Unsuccessful Nests	Probability[a]
1	33.8 (5)	23.1 (3)	0.038
2	24.5 (5)	21.4 (17)	0.338
3	39.1 (1)	18.8 (6)	[b]
All Subtypes	30.2 (10)	21.8 (26)	0.049

[a] Probability of a larger difference than that observed within each subtype; level of significance determined by randomization test (Sokal and Rohlf 1968: 629).

[b] Statistical comparison of means not feasible due to sample size of 1 for successful nests.

Table 17. Mean height (cm) of the major forage grasses within 9m of successful nests versus that within 9m of unsuccessful nests in the Shinnery Oak-Tallgrass subtypes. Sample sizes in parentheses.

Species	Subtype 1			Subtype 2			Subtype 3		
	Successful (5)	Unsuccessful (3)	Probability[a]	Successful (4)	Unsuccessful (17)	Probability[a]	Successful (1)	Unsuccessful (6)	Probability[a]
Sand bluestem	94.1 (70)	43.7 (72)	0.001	26.0 (80)	25.0 (368)	0.751	27.4 (4)	10.9 (64)	0.346
Little bluestem	76.5 (44)	30.9 (65)	0.001	51.4 (73)	32.0 (362)	0.001	-	12.9 (118)	-
Dropseed	46.0 (65)	24.5 (69)	0.001	24.0 (85)	22.5 (373)	0.470	39.1 (24)	11.0 (125)	0.001

[a]Probability of a larger difference than that observed between means of each species; level of significance determined by student's t-test.

Table 18. Percent grazing utilization[a] of the major forage grasses within 9m of successful nests versus that within 9m of unsuccessful nests in the Shinnery Oak-Tallgrass subtypes. Sample sizes in parentheses.

	Subtype 1			Subtype 2			Subtype 3		
Species	Successful (5)	Unsuccessful (3)	Probability[b]	Successful (4)	Unsuccessful (17)	Probability[b]	Successful (1)	Unsuccessful (6)	Probability[b]
Sand bluestem	23.2 (70)	60.4 (72)	0.001	65.9 (80)	67.9 (368)	0.431	65.4 (4)	82.0 (64)	0.010
Little bluestem	7.0 (44)	27.4 (65)	0.001	12.3 (73)	29.8 (362)	0.001	-	51.5 (118)	-
Dropseed	31.1 (65)	59.0 (69)	0.001	55.5 (85)	57.7 (373)	0.339	42.3 (24)	73.1 (125)	0.001

[a] Grazing utilization estimated from height-weight tables developed after Crafts (1938).

[b] Probability of a larger difference than that observed between means of each species; level of significance determined by student's t-test.

considerably lower (Tables 2, 3) due to heavier grazing (Table 4), nesting success also was much lower (19%); even lower composition and height of sand bluestem in subtype 3 (Tables 2,3) under heaviest grazing (Table 4) paralleled even lower nesting success (14%). So close was this relationship between composition of sand bluestem and nesting success that relative index values of these parameters in each subtype were nearly identical (Table 19).

Table 19. Nesting success in relation to percent of sand bluestem in the Shinnery Oak-Tallgrass subtypes.

Subtype	Nesting Success: No. Successful Nests/ Total Nests	Nesting Success: %	Index to Nesting Success[a]	Index to Sand Bluestem Composition[b]
1	5/8	66	5.1	5.4
2	4/21	19	1.5	1.7
3	1/7	13	1.0	1.0
Total	10/36	28		

[a]Percent nesting success for each subtype divided by percent nesting success in subtype 3, where value was lowest.

[b]Percent composition of sand bluestem for each subtype (Table 2) divided by percent composition of sand bluestem in subtype 3 (Table 2), where value was lowest.

CONCLUSIONS AND RECOMMENDATIONS

The common growth form of sand bluestem (tall, wide, with individual stems not closely spaced) enhances success of lesser prairie chicken nests by providing superior concealment from predators and other disturbances. Where sand bluestem is abundant and lightly grazed or ungrazed within the shinnery oak plant community (as in subtype 1), nesting success is high. Conversely, areas of shinnery-dominated rangeland that are devoid of sand bluestem due to heavy livestock grazing (as in subtype 3) are not conducive to nesting success; females in these areas use nest cover provided by a variety of plants that are unpalatable to livestock, but these plants do not provide the superior concealment afforded by sand bluestem.

Vegetational composition of subtype 1 (Table 1) provides an appropriate goal for efforts to restore prime nesting habitat in shinnery-dominated areas of lesser prairie chicken range in eastern New Mexico, west Texas, and parts of north Texas and west-central Oklahoma. Subtype 1 apparently is near climax for this region (Allred 1956; R.D. Pettit, Texas Tech. Univ., Lubbock, pers. comm.), and therefore provides approximately the greatest abundance of sand bluestem attainable by manipulation of native vegetation. This need for restoration of sand bluestem and other climax tallgrasses is indicated by the fact that areas like subtype 1 make up less than 5% of the shinnery rangeland in New Mexico, and make up an even smaller land area in west Texas (F.S. Guthery, Texas Tech. Univ., Lubbock, pers. comm.). For areas of shinnery oak rangeland where development of vigorous stands of sand bluestem is not feasible due to local site factors (soil type, topography, past land use, etc.), restoration of native tall-grasses most similar in growth form to sand bluestem is recommended. Big bluestem (*Andropogon gerardii*), Indiangrass (*Sorghastrum nutans*), and switchgrass (*Panicum virgatum*) are examples of tallgrasses found on many shinnery oak sites that often have growth forms similar to sand bluestem.

Several management techniques should be used to restore lesser prairie chicken nesting habitat. Significant reductions in livestock grazing pressure must first occur to allow sufficient recovery and regrowth of tallgrasses, so that a reserve of residual cover will accumulate; this reserve of dead, standing tallgrass is often used as nest cover. Interspersion of livestock exclosures of relatively large size (40-50 ha) also would produce the desired recovery of tall-grasses in areas of moderate grazing, where sufficient rootstock of bluestems exist for quick regrowth. These exclosures could later be removed or rotated by season or year, so that some grazing could occur in areas where sufficient recovery of bluestems has occurred.

Concurrent with reductions in grazing pressure should be control of shinnery oak. Partial reductions in shinnery density are desirable for many overgrazed areas where this species' continuous root system effectively prevents recovery of tallgrasses, even after considerable reductions in grazing pressure have occurred. Techniques and guide-lines for shinnery control have been suggested by Pettit (1979) and by Doerr and Guthery (1980).

CONCLUSIONS AND RECOMMENDATIONS

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Although longtime heavy grazing has contributed to deterioration of much lesser prairie chicken habitat (Duck and Fletcher 1944, Hamerstrom and Hamerstrom 1961, Jackson and DeArment 1963), management of livestock and prairie chickens need not continue in conflict. Restoration of bluestem tallgrass (especially sand bluestem) in lesser prairie chicken range would provide for greatly increased production of livestock forage, as well as enhanced prairie chicken nesting habitat. Moreover, light to moderate grazing can benefit prairie chicken habitat by stimulating growth of grasses and by creating or maintaining an interspersion of stands dominated by shinnery oak and/or midgrasses (three-awns and dropseeds); the shinnery areas provide key foraging habitat in summer and the plant itself is an important year-round food, while areas dominated by midgrasses are preferred foraging habitat during fall and winter (Davis et. al 1979). However, these additional habitat needs (in contrast to nesting habitat) are also met within areas like subtype 1 (Davis et. al 1979), so that year-round habitat needs remain dependent upon a shinnery plant community co-dominated by bluestem tallgrasses, where livestock grazing is relatively light.

Land uses in direct conflict with lesser prairie chicken habitat needs include conversion of rangeland to cultivation, off-road vehicle use, and oil exploration and development; these and related land uses are increasing throughout lesser prairie chicken range (Jackson and DeArment 1963, Crawford and Bolen 1976, Davis et. al 1979, Horak 1979), and could pose major threats to the species' preservation.

Restoration and maintenance of bluestem tallgrass in the shinnery oak community will mitigate against such habitat losses, and insure the existence of secure, huntable populations of lesser prairie chickens in the future.

LITERATURE CITED

Allred, B.W. 1956. Mixed prairie in Texas. Pp. 267-283 In: Grasslands of the great plains. Johnson Publ. Co., Lincoln. 445 pp.

Bailey, F.M. 1928. Birds of New Mexico. Judd and Detweiller, Inc., Washington, D.C. 807 pp.

Bent, A.C. 1932. Life histories of North American gallinaceous birds. U.S. Nat. Mus. Bull. 162: 280-284.

Campbell, H. 1972. A population study of lesser prairie chickens in New Mexico. J. Wildl. Manage. 36: 689-699.

Copelin, F.F. 1963. The lesser prairie chicken in Oklahoma. Okla. Wildl. Conserv. Dep. Tech. Bull. 6. 58 pp.

Correll, S.D. and M.C. Johnston. 1970. Manual of the vascular plants of Texas. Texas Res. Found. 1881 pp.

Crafts, E.C. 1938. Height-volume distribution in range grasses. J. For. 36: 1182-1185.

Crawford, J.A. and E.G. Bolen. 1976. Effects of land use on lesser prairie chicken populations in west Texas. J. Wildl. Manage. 40: 96-104.

Davis, C.A., T.Z. Riley, R.A. Smith, H.R. Suminski, and M.J. Wisdom. 1979. Final Report: Habitat evaluation of lesser prairie chickens in eastern Chaves County, New Mexico. New Mexico St. Univ. Agr. Exp. Stn., Las Cruces, New Mexico. 141 pp.

Davis, C.A., T.Z. Riley, J.F. Schwarz, H.R. Suminski, and M.J. Wisdom. 1980. Capturing female prairie chickens on spring leks. Proc., Prairie Grouse Symp. In Press.

Dill, H.H. and W.H. Thornsberry. 1950. A cannon-projected net trap for capturing waterfowl. J. Wildl. Manage. 14: 132-137.

Doerr, T.B. and F.S. Guthery. 1980. Effects of shinnery oak control on lesser prairie chicken habitat. Proc., Prairie Grouse Symp. In Press.

Donaldson, D.D. 1969. The effect on lesser prairie chickens of brush control in western Oklahoma. Ph.D. Thesis. Oklahoma St. Univ., Stillwater. 80 pp.

Duck, L.G. and J.B. Fletcher. 1944. A survey of the game and fur-bearing animals of Oklahoma. Okla. Game and Fish. Dept. Bull. 3. 144 pp.

Evans, R.A. and R.M. Love. 1957. The step-point method of sampling -- a practical tool in range research. J. Range Manage. 10: 208-212.

Heady, H.F., R.P. Gibbons, and R.W. Powell. 1959. A comparison of the charting, line intercept, and line point methods of sampling shrub types of vegetation. J. Range Manage. 12: 180-188.

Horak, J. 1979. The lesser prairie chickens of Kansas. Proc., Pr. Gr. Tech. Council 13: In Press.

Jackson, A.S. and R. DeArment. 1963. The lesser prairie chicken in the Texas panhandle. J. Wildl. Manage. 27: 733-737.

Jones, R.E. 1963. Identification and analysis of lesser and greater prairie chicken habitat. J. Wildl. Manage. 27: 757-778.

Levy, E.B. and E.A. Madden. 1933. The point method of pasture analysis. New Zealand J. Agr. 46: 267-279.

Ligon, J.S. 1961. New mexico birds and where to find them. Univ. of New Mexico Press, Albuquerque. 360 pp.

Maker, H.J., V.G. Link, J.F. Anderson, and M.V. Hodson. 1971. Soil associations and land classification for irrigation: Chaves County. New Mexico St. Agr. Exp. Stn. Res. Rep. 192. 48 pp.

Pettit, R.D. 1979. Effects of picloram and tebuthiuron pellets on sand shinnery oak communities. J. Range Manage. 32: 196-200.

Riley, T.Z. 1978. Nesting and brood-rearing habitat of lesser prairie chickens in southeastern New Mexico. M.S. Thesis, New Mexico St. Univ., Las Cruces. 60 pp.

Sell, D.L. 1979. Spring and summer movements and habitat use by lesser prairie chicken females in Yoakum County, Texas. M.S. Thesis, Texas Tech Univ., Lubbock. 41 pp.

Sokal, R.R. and F.J. Rohlf. 1968. Biometry. Freeman and Co., San Francisco. 776 pp.

Sutton, G.M. 1964. On plumage of the young lesser prairie chicken. Southwest Nat. 91: 1-5.